

WHAT IS CLAIMED IS:

MacPherson, Sub claim
1. A payload isolation system for isolating a payload from a base structure upon which the payload is supported, the payload isolation system comprising:
motion constraint means for maintaining a parallel relationship between the payload and the base structure; and
support means for providing vertical and/or lateral support of the payload relative to the base structure such that the transmission of vertical and/or lateral vibration between the payload and the base structure are suppressed.

(if motion constraint means is linkage what's support means for fig 1 eg)

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fig 2. The payload isolation system of claim 1, wherein the motion constraint means comprises a mechanical linkage.

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fig 3. The payload isolation system of claim 2, wherein the mechanical linkage comprises at least one parallelogram linkage disposed between the payload and base structure.

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fig 4. The payload isolation system of claim 3, wherein each of the at least one parallelogram linkage comprises first and second parallelogram sub-linkages, the first and second parallelogram sub-linkages sharing a common member, one of the first or second parallelogram sub-linkages being fixed to the payload or a portion thereof, the other of the first or second parallelogram sub-linkages being fixed to the base structure or a portion thereof.

Sub 2 *MacPherson*
1 5. The payload isolation system of claim 4, wherein the at
2 least one parallelogram linkage comprises two or more
3 parallelogram linkages wherein at least two of the parallelogram
4 linkages are configured non-parallel to each other. (fig 2)

linkages not parallel

Sub d1 *fig 3* *Subcliffe*
1 6. The payload isolation system of claim 1, wherein at
2 least a portion of the vertical and/or lateral support is
3 provided by actuators arranged to apply a vertical and/or lateral
4 force against the payload. *actuators*

fig 13 *Subcliffe (calling (8 damping))*
1 7. The payload isolation system of claim 1, further
2 comprising damping means for resisting relative displacement
3 and/or velocity between the payload and base structure. *damping means*

fig 8 *MacPherson?*
1 8. The payload isolation system of claim 2, wherein the
2 mechanical linkage comprises at least one scissor linkage each
3 having first and second scissor sub-linkages disposed between the
4 payload and base structure, the first and second scissor sub-
5 linkages being connected to each other by first and second common
6 members, a first end of each of the first and second scissor sub-
7 linkages being fixed to the payload or a portion thereof and a
8 second end of the first and second scissor sub-linkages being
9 fixed to the base structure or a portion thereof.

scissor linkage

not shown?

Sub 2
1 9. The payload isolation system of claim 8, wherein the at
2 least one scissor linkage comprises two or more scissor linkages,

not shown

diff betw. scissor linkage & scissor sublinkage

at least two of the parallelogram linkages being configured non-parallel to each other.

Fig 10. The payload isolation system of claim 8, wherein the support means comprises a spring means and a linear actuator means in series disposed on one of the first or second common members.

Fig 11. The payload isolation system of claim 8, wherein the support means comprises an elastic means for biasing the first and second common members together.

Fig 12. The payload isolation system of claim 1, wherein the support means provides one of vertical or lateral support of the payload relative to the base structure.

Fig 13. The payload isolation system of claim 1, wherein the support means provides both vertical and lateral support of the payload relative to the base structure.

Fig 14. The payload isolation system of claim 1, wherein the support means comprises a deformable mat having at least one internal tubular cavity such that the deformable mat exhibits nonlinear elastic characteristics in response to an effective weight of the payload.

Support means =
Spring means
& linear actuator

Support means =
Elastic means

Deformable
mat
30

1 *Fig 5* 15. The payload isolation system of claim 14, wherein the *non-linear*
2 non-linear elastic characteristics comprise a substantially rigid *Charact.*
3 characteristic at low and high levels of deformation and a
4 compliant characteristic at intermediate levels of deformation.

11/18
1 *Fig 4A* 16. The payload isolation system of claim 14, wherein the
2 at least one internal tubular cavity comprises a plurality of *internal*
3 internal tubular cavities interconnected to each other such that *tubular*
4 the plurality of internal tubular cavities act as a single *Cavities*
5 cavity.

Sutcliffe & Goldbach
1 *Fig 6* 17. The payload isolation system of claim 1, wherein the
2 support means comprises a bottom plate fixed to one of the
3 payload or base structure or portions thereof, a top plate
4 movable relative to the bottom plate and fixed to the other of
5 the payload or base structure or portions thereof, the support
6 means further comprising a compressible material disposed in a
7 space between the top and bottom plates. *spec?*

4A
1 *Fig 6* 18. The payload isolation system of claim 17, wherein the
2 space between the top and bottom plates defines an annular cavity
3 and wherein the compressible material disposed in the space is an
4 elastomeric extruded tubular element, the elastomeric extruded
5 tubular element having a tubular cavity running therethrough and
6 being coiled within the space in a helical manner to thereby fill
7 the space.

ref
Fig 6?

1 19. The payload isolation system of claim 1, further *no means*
2 comprising a payload adjustment means for adjusting the level of
3 support of the support means in response to a variation in an
4 effective payload weight, and/or a variation in a relative
5 distance between the payload and the base structure.

1 20. The payload isolation system of claim 19, wherein the
2 payload adjustment means comprises:

3 support adjustment means for adjusting the level of
4 support of the support means; and

5 a feedback *loop* means for sensing a change in relative
6 distance between the payload and the base structure and
7 controlling the support adjustment means in response thereto.

Sub 1
1 21. The payload isolation system of claim 20, wherein the
2 support adjustment means comprises:

3 a deformable mat having at least one internal tubular
4 cavity; and

diff from support means
5 a gas source in communication with the at least one
6 internal cavity;

7 wherein the feedback means controls the gas pressure
8 level in the internal tubular cavity in response to the change in
9 relative distance between the payload and the base structure.

Sub 1
1 22. The payload isolation system of claim 20, wherein the
2 support adjustment means comprises:

3 a bottom plate fixed to one of the payload or base
4 structure or portions thereof;

5 a top plate movable relative to the bottom plate and
6 fixed to the other of the payload or base structure or portions
7 thereof;

8 an elastomeric extruded tubular element disposed in an
9 annular cavity defined between the top and bottom plates, the
10 elastomeric extruded tubular element having a tubular cavity
11 running therein and being coiled within the space in a helical
12 manner to thereby fill the space; and

13 a gas source in communication with the tubular cavity;
14 wherein the feedback means controls the gas pressure
15 level in the tubular cavity in response to the change in relative
16 distance between the payload and the base structure.

17 23. The payload isolation system of claim 20, wherein the
18 support adjustment means comprises:

19 a deformable mat having at least one internal tubular
20 cavity; and ^{spec?}

21 a ramp means for engaging the deformable mat to vary an
22 amount of surface area in contact with the payload; and

23 drive means for driving the ramp means between
24 locations in which more or less surface area is in contact with
25 the payload;

26 wherein the feedback means controls the drive means to
27 change the amount of surface area in contact with the payload.

1 *fig 11* 24. The payload isolation system of claim 20, wherein the
2 feedback means comprises: *spec?*
3 distance signal generation means for generating a
4 distance signal proportionate to the sensed relative distance
5 between the payload and the base structure;

cont 6 a first low pass filter for converting the distance
7 signal into a slowly varying signal representing average position
8 along with a small high frequency ripple component;

9 a summer for subtracting a reference signal from the
10 slowly varying signal to provide an output error signal;

11 a gain means for outputting a signal indicative of
12 vibrational peaks from an input of the error signal;

13 a second low pass filter for averaging the vibrational
14 peaks signal into a final error signal; and

15 a throttling transducer means for responding to the
16 final error signal which is input to the support adjustment means
17 thereby more efficiently controlling the support adjustment means
18 and reducing vibrational chattering of the support adjustment
19 means.

20
21 25. The payload isolation system of claim 1, wherein the *- 112*
22 payload and base structure are components of a rocket and wherein
23 the effective weight of the payload varies with time.

24 26. The payload isolation system of claim 1, wherein the
25 support means comprises one or more of the following:

3 a deformable mat having at least one internal tubular
4 cavity such that the deformable mat exhibits nonlinear elastic
5 characteristics in response to an effective weight of the
6 payload;

7 at least one first motor disposed between the payload
8 and base structure for providing vertical support of the payload,
9 the at least one first motor being under the control of a control
10 means in response to detected vertical disturbances of the
11 payload relative to the base structure; and

12 at least two second motors disposed between the payload
13 and base structure for providing ^{sec}lateral support of the payload,
14 the at least two second motors being under the control of a
15 control means in response to detected lateral disturbances of the
16 payload relative to the base structure.

MacPherson
1 27. A motion constraint mechanism comprising:
2 *Sy1* a first mechanical linkage disposed between a payload
3 and a base structure; and

4 at least a second mechanical linkage arranged relative
5 to the first mechanical linkage such that the first and at least
6 second mechanical linkages maintain a parallel relationship
7 between the payload and the base structure.

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1 *Sy1* 28. The motion constraint mechanism of claim 27, wherein at
2 least one of the first or at least second mechanical linkages
3 comprises a parallelogram linkage disposed between the payload
4 and base structure.

29. The motion constraint mechanism of claim 28, wherein each of the parallelogram linkages comprises first and second parallelogram sub-linkages, the first and second parallelogram sub-linkages sharing a common member, one of the first or second parallelogram sub-linkages being fixed to the payload or a portion thereof, the other of the first or second parallelogram sub-linkages being fixed to the base structure or a portion thereof.

30. The motion constraint mechanism of claim 27, wherein the first and at least second mechanical linkages are arranged non-parallel to each other.

31. The motion constraint mechanism of claim 27, wherein at least one of the first or at least second mechanical linkages comprises a scissor linkage having first and second scissor sub-linkages disposed between the payload and base structure, the first and second scissor sub-linkages being connected to each other by first and second common members, a first end of each of the first and second scissor sub-linkages being fixed to the payload or a portion thereof and a second end of the first and second scissor sub-linkages being fixed to the base structure or a portion thereof.

32. The motion constraint mechanism of claim 31, further comprising support means for providing vertical and/or lateral support of the payload relative to the base structure such that

what's the support means

4 the transmission of vertical and/or lateral vibration between the
5 payload and the base structure are suppressed.

1 33. The motion constraint mechanism of claim 31, wherein
2 the support means comprises a spring means and a linear actuator
3 means in series disposed on one of the first or second common
4 members.

1 34. The motion constraint mechanism of claim 31, wherein
2 the support means comprises an elastic means for biasing the
3 first and second common members together.

1 35. The motion constraint mechanism of claim 27, further
2 comprising support means for providing vertical and/or lateral
3 support of the payload relative to the base structure such that
4 the transmission of vertical and/or lateral vibration between the
5 payload and the base structure are suppressed.

1 36. A method for constraining motion between a payload and
2 a base structure, the method comprising the steps of:

3 providing a first mechanical linkage disposed between
4 the payload and the base structure;

5 providing at least a second mechanical linkage disposed
6 between the payload and the base structure; and

7 arranging the first and at least second mechanical
8 linkages relative to each other such that the first and at least

9 second mechanical linkages maintain a parallel relationship
10 between the payload and the base structure.

37. The method of claim 36, wherein the arranging step
comprises configuring the first and second mechanical linkages
non-parallel to each other.

38. The method of claim 36, further comprising the step of
providing vertical and/or lateral support of the payload relative
to the base structure such that the transmission of vertical
and/or lateral vibration between the payload and the base
structure are suppressed.

39. A support apparatus for providing vertical and/or
lateral support of a payload relative to the base structure such
that the transmission of vertical and/or lateral vibration
between the payload and the base structure are suppressed, the
support apparatus comprising:

a deformable member exhibiting nonlinear elastic
characteristics in response to an effective payload weight;

support adjustment means for supporting the effective
payload weight; and

effective payload adjustment means for adjusting the
level of support of the support means in response to a varying
effective payload weight.

1 40. The support apparatus of claim 39, wherein the
2 deformable member further having at least one internal tubular
3 cavity.

1 41. The support apparatus of claim 39, wherein the non-
2 linear elastic characteristics comprise a substantially rigid
3 characteristic at low and high levels of deformation and a
4 compliant characteristic at intermediate levels of deformation.

1 42. The support apparatus of claim 40, wherein the
2 deformable member comprises a deformable mat and the at least one
3 internal tubular cavity comprises a plurality of internal tubular
4 cavities.

1 43. The support apparatus of claim 42, wherein the
2 plurality of internal tubular cavities are interconnected to each
3 other such that the plurality of internal tubular cavities act as
4 a single cavity.

1 44. The support apparatus of claim 39, wherein the *spec?*
2 deformable member comprises a bottom plate fixed to one of the
3 payload or base structure or portions thereof, a top plate
4 movable relative to the bottom plate and fixed to the other of
5 the payload or base structure or portions thereof, the deformable
6 member further comprising a compressible material disposed in a
7 space between the top and bottom plates.

1 45. The support apparatus of claim 44, wherein the space
2 between the top and bottom plates defines an annular cavity and
3 wherein the compressible material disposed in the space is an
4 elastomeric extruded tubular element, the elastomeric extruded
5 tubular element having a tubular cavity running therein and being
6 coiled within the space in a helical manner to thereby fill the
7 space.

Sub
a1
1 46. The support apparatus of claim 39, wherein the
2 effective payload adjustment means comprises feedback means for
3 sensing a change in relative distance between the payload and the
4 base structure and controlling the support adjustment means in
5 response thereto.

Sub
b5
1 47. The support apparatus of claim 46, wherein the support
2 adjustment means comprises a gas source in communication with the
3 at least one internal cavity wherein the feedback means controls
4 the gas pressure level in the internal tubular cavity in response
5 to the change in relative distance between the payload and the
6 base structure.

1 48. The support apparatus of claim 46, wherein the
2 deformable member comprises a deformable mat and wherein the
3 support adjustment means comprises;
4 a ramp means for engaging the deformable mat to vary an
5 amount of surface area in contact with the payload; and

6 drive means for driving the ramp means between
7 locations having more or less surface area in contact with the
8 payload;

9 wherein the feedback means controls the drive means to
10 change the amount of surface area in contact with the payload.

1 49. The support apparatus of claim 46, wherein the feedback
2 means comprises:

3 distance signal generation means for generating a
4 distance signal proportionate to the sensed relative distance
5 between the payload and the base structure;

6 a first low pass filter for converting the distance
7 signal into a slowly varying signal representing average position
8 along with a small high frequency ripple component;

9 a summer for subtracting a reference signal from the
10 slowly varying signal to provide an output error signal;

11 a gain means for outputting a signal indicative of
12 vibrational peaks from the input of the error signal;

13 a second low pass filter for averaging the vibrational
14 peaks signal into a final error signal; and

15 a throttling transducer means for responding to the
16 final error signal which is input to the support adjustment means
17 thereby more efficiently controlling the support adjustment means
18 and reducing vibrational chattering of the support adjustment
19 means.